

## CLAIMS

What is claimed is:

- 1        1.        A method for determining a parameter of interest of a fluid in a subsurface region  
2                of earth formations comprising:
  - 3                (a)       obtaining seismic survey information about the subsurface region;
  - 4                (b)       identifying at least one seismic horizon of interest from the obtained  
5                        survey information;
  - 6                (c)       measuring at least one seismic attribute for the at least one horizon of  
7                        interest at a plurality of locations, and obtaining a first probability density  
8                        function (PDF) thereof;
  - 9                (d)       defining a plurality of realizations of a model including at least one rock  
10                        property in the region of interest;
  - 11                (e)       defining at least one trial value of at least one property of said fluid and  
12                        obtaining from said at least one trial value and said plurality of  
13                        realizations of said model a second PDF associated with said at least one  
14                        seismic attribute and said fluid property; and
  - 15                (f)       determining from the first and second probability density functions said  
16                        parameter of interest.

- 1        2.        The method of claim 1 wherein said seismic survey is at least one of the group  
2                consisting: (i) a P-P survey, (ii) a P-S survey, (iii) a S-S survey, and, (iv) a S-P  
3                survey.
- 1        3.        The method of claim 1 wherein said at least one seismic horizon corresponds to  
2                one of (i) a top of a reservoir, (ii) a bottom of a reservoir, and, (iii) a reservoir  
3                between an upper and a lower seal.
- 1        4.        The method of claim 1 wherein said at least one seismic attribute is selected from  
2                the group consisting of (i) an impedance, (ii) an amplitude of a stack trace, (iii) at  
3                least one coefficient of a Taylor series expansion of an amplitude in powers of  
4                 $\sin\theta$ , (iv) a reflectivity, (iv) a fractional change in density, and., (v) an average  
5                value of  $(V_p / V_s)^2$ .
- 1        5.        The method of claim 1 wherein the plurality of locations includes a reference  
2                location where the parameter of interest is known.
- 1        6.        The method of claim 1 wherein the plurality of locations includes a test location  
2                where the parameter of interest is to be determined.
- 1        7.        The method of claim 1 wherein obtaining said first PDF further comprises:  
2                (i)        measuring said at least one seismic attribute at a plurality of locations;

- 3 (ii) determining a variability of said seismic attribute at said plurality of  
4 locations in (i); and  
5 (iii) determining an indication of variability of said at least one seismic  
6 attribute.

1 8. The method of claim 1 wherein said at least one seismic attribute comprises a  
2 plurality of seismic attributes.

1 9. The method of claim 4 wherein said at least one seismic attribute comprises a  
2 plurality of seismic attributes.

1 10. The method of claim 8 wherein said first PDF comprises a multivariate PDF.

1 11. The method of claim 9 wherein said first PDF comprises a multivariate PDF.

1 12. The method of claim 1 wherein the at least one rock property is a property of a  
2 seal rock.

1 13. The method of claim 1 wherein the at least one rock property is a property of a  
2 seal rock.

1 14. The method of claim 1 wherein said at least one property is a compressional wave  
2 velocity.

- 1        15.     The method of claim 1 wherein said at least one seismic horizon corresponds to  
2               one of a reservoir between an upper and a lower seal, the method further  
3               comprising determining a tuning curve.
- 1        16.     The method of claim 15 wherein determining said tuning curve further comprises  
2               defining an overburden model.
- 1        17.     The method of claim 1 wherein determining said second PDF further comprises  
2               using a convolutional model.
- 1        18.     The method of claim 17 further comprising defining a wavelet for said  
2               convolutional model.
- 1        19.     The method of claim 18 wherein said wavelet is selected from the group  
2               consisting of (i) a wavelet derived from a bandpass filter, (ii) Berlage, (iii) a  
3               wavelet derived from a Butterworth filter, (iv) a Gabor wavelet, (v) a Gaussian  
4               wavelet, (vi) an Ormsby wavelet, (vii) a Rayleigh wavelet, and, (viii) a Ricker  
5               wavelet.
- 1        20.     The method of claim 14 wherein said at least one property further comprises an  
2               additional rock property selected from (i) a shear wave velocity, and, (ii) a  
3               density..

- 1        21.     The method of claim 14 wherein said plurality of realizations further comprises  
2                perturbations of said compressional velocity.
- 1        22.     The method of claim 21 wherein said plurality of realizations further comprises  
2                perturbations of at least one additional property selected from (i) a shear velocity,  
3                and, (ii) a density, wherein said perturbations are relative to an expected trend  
4                value of said additional property.
- 1        23.     The method of claim 1 wherein said parameter of interest is a probability that the  
2                measured plurality of seismic attributes is associated with said trial value of said  
3                at least one fluid property.
- 1        24.     The method of claim 1 wherein said parameter of interest comprises a PDF of  
2                said trial value of said at least one fluid property.
- 1        25.     The method of claim 1 wherein said at least one fluid property is selected from  
2                the group consisting of (i) a fluid modulus, (ii) a density, and, (iii) a fluid  
3                saturation.
- 1        26.     The method of claim 1 wherein determining said second PDF further comprises  
2                using a critical porosity model.

1        27.    The method of claim 1 wherein determining said second PDF further comprises  
2            using a form of the Gassman equation.